PHOTOMETRY

Labsphere Integrating Sphere Spectroradiometers

High Speed Integrating Sphere Systems Accurately Measure Luminous Flux, CCT & CRI from LEDs, Lamps & Luminaires in Seconds

Labsphere Integrating Sphere Spectroradiometers provide the fastest means of measuring the total light output (flux) of lamps, LEDs, luminaires and solid state lighting (SSL). Unlike scanning monochromators, our array spectrometers capture a full spectrum (350-1000nm) in milliseconds. Unlike filter photometers, a spectroradiometer will give accurate flux and chromaticity readings regardless of the type of source under test.

Labsphere light measurement integrating spheres come in diameters from 25cm to 3m, so you can test anything from just a single LED or small lamp, through LED light engines & downlighters, through to the largest luminaires and street lights. All integrating spheres provide the option of either making 2π forward flux measurements with externally mounted sources or 4π total flux measurements with samples placed in the centre of the sphere. Parameters reported include: radiant flux (W/nm); luminous flux - photopic & scotopic (lumens); CIE chromaticity (xy, u'v'); correlated colour temperature (Kelvin); dominant wavelength and purity; and colour rendering (Ra, $R_{1\text{-}14}$). With our latest TOCS option, the LED is mounted on a temperature-controlled heat sink, which means that you can make automated measurements of flux and colour as a function of device temperature and drive current / voltage (please refer to the separate TOCS brochure for details).

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LEDs - THE TRUTH IS OUT THERE

LEDs are being used almost everywhere - not least in more energy efficient solid state lighting (SSL). The trouble is, you can't just fit ten "100 lumen" LEDs to your luminaire and expect the luminaire to deliver 1,000 lumens. An LED rated to give 100 lumens by the manufacturer will have been tested under idealised laboratory conditions, specifically at a junction temperature of 25°C. When you put lots of LEDs into a luminaire they get hot - even if you've designed in proper heat sinking. It is typical for an LED to operate at over 75°C in a high power luminaire. With increased temperature comes decreased flux - expect to see a 30% drop in lumen output (and a significant shift in CCT) when an LED is fitted into a luminaire. Of course, there are other losses from the lens, reflector or driver, but the thermal loss is the most significant. This is why luminaire developers and manufacturers find it necessary to test the colour and flux of the LEDs and LED modules they purchase to verify conformance to specification, and to then test the output of the luminaire itself. Simply estimating the performance of the luminaire based upon the bare LED specification is risky.

Pro-Lite supplies an affordable goniophotometer that can be used to collect photometric data from a luminaire in .ies and .ldt formats - this also yields a total luminous flux measurement as the 2π integral of the directional intensity. However, a goniometer scan takes up to 2 hours (after you've let the luminaire stabilise), so a quick and simple method of measuring flux and colour is essential. An in-house photometric laboratory containing a goniophotometer and an integrating sphere gives out an important message to your customers - that you are a serious and credible supplier of solid state lighting.

THE DARK ART OF LIGHT MEASUREMENT

Why use a proper integrating sphere when a simple integrating cube or geodesic chamber painted white and coupled to an inexpensive lux meter will do the job just as well? It's all to do with how an integrating sphere works. Next time you visit a test lab with a sphere, try out the following experiment. With a lamp burning in the sphere, gradually close the sphere door and watch how all the shadows completely disappear. This means that the light field is equal at all points on the sphere wall, which in turn means that what the photometer sees is representative of the whole. In practical terms, the measured flux will be independent of the source size, shape and beam pattern. Only a properly designed integrating sphere can ensure that you get an accurate reading – this is based on a combination of a spherical surface coated with a high reflectance, matte integrating sphere paint.

What of the inexpensive lux meter? A simple filter photometer can give good results if all you do is test tungsten lamps but try measuring sources with discontinuous spectra (e.g. LEDs, CFLs, discharge lamps) and you will suffer from very high errors (over 200% has been known). This is because a simple filter photometer doesn't match the human eye response, or CIE V(λ) function at all wavelengths. Industry standards (e.g. IES LM79, CIE 127) recommend that you use a spectroradiometer with your integrating sphere rather than a photometer.

Labsphere systems employ a compact CCD array spectrometer coupled to the sphere via optical fibre which captures a complete spectrum (e.g. 350-1000nm) in a few of tens of milliseconds. Such speed was unthinkable back in the days when a scanning monochromator took 5 minutes to scan the light source one wavelength at a time. A high speed CCD spectrometer not only saves time and boosts your productivity, it also allows you to plot light output over time - this allows you to confirm that the lamp has stabilised ready for measurement. Measuring "cold lumens" (not waiting for the LED to warm up) is a common mistake.

Labsphere integrators also correct for sample absorption. Consider that a luminaire placed inside a sphere not only emits light - it also absorbs light. This can lead to the measured flux being recorded low by some tens of percent. This error is corrected by means of an auxiliary lamp which is used to gauge the absorption of the device under test compared with the calibration lamp.

All Labsphere integrating spheres provide the option of either making 2π forward flux measurements with externally mounted sources (ideal for downlighters) or 4π total flux measurements with samples placed in the centre of the sphere. Spheres of 50cm and larger provide a height adjustable post mount for 4π measurements which can be mounted from the bottom or the top of the sphere - this allows downlighter fittings to be tested in their "natural" orientation. For 2π downwards facing measurements with the source outside the sphere, the sphere mount can be customised to rotate 90°.

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The Perfect Sphere is Perfectly Impossible

We're not saying that Labsphere integrating spheres aren't perfect - far from it - however there is no one-size-fits-all policy when it comes to choosing the correct size for your application. Put too large a light source in a given size sphere and it won't integrate properly. As a guide, for 4π measurements the sphere diameter should be 10x the sample size (for 2D & 3D sources) or 1.5x the length of a linear device. For 2π measurements, the maximum recommended sample size is 1/3 the sphere diameter (note that the sphere port may have to specially enlarged on a custom basis - see specifications on the reverse for the standard port sizes).

Not that you need a full sphere if you just wish to test an LED downlighter for 2π flux. The Labsphere Half Moon Systems employ a hemisphere plus a plane mirror - the hemisphere is coated as normal with a matte, white integrating sphere paint, while the other hemisphere is formed of the mirror image of the real hemisphere. In effect, the Half Moon is a sphere with half the size and twice the photometric sensitivity of a full sphere. By mounting the SSL sample and its drive electronics outside of the "sphere", thermal management problems are much reduced and measurement speed and accuracy are improved. You also benefit from being able to test a downlighter in its "natural" orientation without having to climb to the north pole of a large integrating sphere. Half Moon systems are available with hemispheres of 30, 50 & 100cm diameter. Please refer to the separate Half Moon brochure for details.

Photometric Measurements Don't Have to be Testing

LightMtrX software is the beating heart of our Labsphere integrating sphere and Half Moon spectroradiometer systems. LightMtrX performs spectroradiometric, photometric and colorimetric measurements of LEDs and other light sources. Our opinion - and that of our customers - is that LightMtrX is quite simply the easiest to use software yet released for performing light source measurements. It features user-defined "methods" which simplify repeat testing, an auxiliary correction capability to avoid low readings when the sample is inside the sphere and the ability to perform both electrical and optical testing in conjunction with a Keithley 2400 series SourceMeter.

LightMtrX reports the following spectroradiometric, photometric and colorimetric parameters:

- Spectral radiant flux, 350-1000nm (W/nm).
- Luminous flux - photopic & scotopic observers (lumens).
- Luminous efficacy (Watts per lumen) - requires optional Keithley 2400 SourceMeter.
- CIE chromaticity (xy, u'v').
- Correlated colour temperature, CCT (Kelvin).
- Dominant wavelength & spectral purity (nm).
- Colour rendering index, CRI (Ra, R_{1-14}).
- Drive current & voltage - requires optional Keithley 2400 SourceMeter.

Chart functions include:

- Spectrum chart (spectral power, W/nm versus nm).
- Temporal chart (user specified parameters plotted over defined time intervals, e.g. luminous flux versus time).
- CIE 1931 chromaticity diagram with user-selectable/definable target quadrangles (e.g. nominal LED CCT bins).
- Lumen output versus temperature & drive current (specific to TOCS systems - see separate brochure).

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Specifications & Ordering Information

Sphere Size	25cm	50cm	1.0m	1.6m	1.9m	3.0m
Max. Lamp Power	100W	400W	1.5KW	4KW	5KW	TBC
2π Port Size	2cm	2cm	5cm	5cm	5cm	5cm
Max. 4π Sample Size	3 x 3 x 3cm	5 x 5 x 5cm	10 x 10 x 10cm	18 x 18 x 18cm	21 x 21 x 21cm	33 x 33 x 33cm
Max. Linear Sample	16cm	33cm	66cm	107cm	127cm	200cm
Max. Luminous Flux	13,000 lumens	18,000 lumens	72,500 lumens	200,000 lumens	260,000 lumens	TBC
Min. Luminous Flux	0.4 lumens	0.6 lumens	2 lumens	6 lumens	8 lumens	TBC

Included in the System:

- Interior access light measurement integrating sphere with internal baffles, cosine diffused detector port, height adjustable centre mount post with breadboard (base down on 25cm sphere, base up & down mounting on larger spheres), ports for electrical feed-through and optional temperature probe and socket for calibration lamp.
  Please note: the 25 & 50cm spheres are designed for use on a bench, while the 1m and larger spheres are floor mounted. The 1m sphere is supplied on lockable castors, while the 1.6m and larger spheres have one fixed hemisphere and the other hemisphere opens on rails.
- CCD spectroradiometer with optical fibre coupling to sphere.
- Standard lamp (spectral radiant flux), NIST traceable.
- Auxiliary lamp for absorption correction.
- Current regulated power supplies for standard and auxiliary lamps.
- LightMtrX software (PC not included).
- On-site commissioning and operator training.
- 1 year hardware warranty.
- 1 year software licence & technical support agreement.

Popular Options:

- Sphere customisation: enlarge 2π port up to a maximum of 1/3 sphere diameter.
- Sphere customisation: rotating sphere mount (allows 2π port to be rotated to north pole position).
- Sphere customisation: sample support bracket for 2π port.
- Sphere customisation: rack mount for system power supplies.
- Set of 3 calibrated standards of spectral radiant flux (recommended for long term calibration traceability).
- Set of 3 uncalibrated optical grade lamps (for user calibration as working standards of spectral flux).
- Thermocouple temperature probe and monitor.
- Cooled CCD array spectrometer.
- Keithley 2400 series SourceMeter (DC supply for LEDs & LED modules).
- Stabilised AC supply.

NOTES

1. The maximum lamp power specified refers to the electrical consumption of an incandescent source.
2. The standard 2π port size is quoted. This port can be enlarged up to 1/3 of the sphere diameter on a custom basis.
3. The photometric specifications quoted refer to the measurement of an incandescent lamp (CIE standard illuminant A). Specfications for other types of light source will differ.
4. The photometric specifications refer to Labsphere integrating systems equipped with the CDS600 or CDS610 spectrometers. Other spectrometer options are available for which different specifications may apply.

PRO-LITE TECHNOLOGY

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Pro-Lite and Sphere Optics provide a solution for almost any application in measuring the colour and brightness of LEDs, luminaires, lamps and displays. From a simple, inexpensive lux meter, to the world's most advanced imaging photometers, from our near-field imaging goniophotometer to our 3m Labsphere integrating sphere spectroradiometer, we have a light measurement system that you can rely upon to give you accurate, repeatable data. We don't just supply state-of-the-art equipmement, we also support you with practical advice and know-how borne out of our decades of experience in light measurement.

Pro-Lite / SphereOptics - your partners in photometry.

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